



LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

The role of iron chemistry on the interpretation of lower mantle heterogeneities

A-L. Auzende, J. Badro, F. J. Ryerson, J. Siebert,
G. Fiquet

October 28, 2008

American Geophysical Union - Fall Meeting '08
San Francisco, CA, United States
December 16, 2008 through December 21, 2008

Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

The role of iron chemistry on the interpretation of lower mantle heterogeneities

A-L. AUZENDE¹, J. BADRO^{1,2}, F.J. RYERSON², J. SIEBERT^{1,2}, G. FIQUET¹

¹ IPGP-IMPMC, Dpt of Mineralogy, Paris, France (auzende@impmc.jussieu.fr,
badro@impmc.jussieu.fr)

² LLNL, University of California, Livermore, USA (ryerson@llnl.gov)

Iron is a major element in the mantle and its chemical behavior (partitioning, spin transition..) affect the physical and transport properties of the phases which host it. Such variations can provide explanations of major heterogeneities observed in the mantle. Magnesium silicate perovskite (Mg,Fe)SiO₃ (*Mg-pv*) and ferropericlase (Mg,Fe)O (*fp*) are the dominant phases in the lower-mantle and can potentially host significant amount of iron. It is thus of prime importance to constrain element partitioning at high pressure for improving models of the deep Earth. We investigated iron partitioning between *Mg-pv* and *fp* synthesised under lower-mantle conditions (up to 115 GPa and 2200 K) in a laser heated diamond anvil cell (LH-DAC). Recovered samples were thinned to electron transparency by focussed ion beam (FIB) and characterized by analytical transmission electron microscopy (ATEM). Additional informations on trace elements were provided by measurements using nanometer scale ion probe (nanoSIMS). Iron concentrations in both phases were obtained from EDX measurements and nanoSIMS and are in excellent agreement. Our results are the first to show that recently reported transitions in the lower-mantle directly affect the evolution of Fe-Mg partitioning between both phases. *Mg-pv* is increasingly iron-depleted above 70-80 GPa possibly due to the high spin-low spin transition of iron in *fp*. Conversely, the perovskite to post-perovskite transition is accompanied by a strong iron enrichment of the silicate phase. We will discuss the implications of these partitioning variations in terms of potential heterogeneities. We will also address shortly the early history of the Earth, as the observation of nanoparticles of metallic iron in the *Mg-pv* bearing runs suggests the disproportionation of ferrous iron and the self-oxidation of the mantle while these particles were not observed when the post-perovskite (*ppv*) phase was present. Implications on the oxidation state of the Earth and core segregation will be discussed.

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.